

# Pesticides Exposure and Cancer Risk



**Horizon**

Department of Public  
Relations and Information  
Sultan Qaboos University

## News Update

- VC's Visit to Czech Republic, Slovakia Ends
- Mind Over Matter
- 21st Century Skills Described as Employable Criteria

## Panorama

- Book Reflects on Glass Transition in Foods

**HORIZON**

ISSUE 367

**Jamal Said Al Riyami**

Editorial Supervision

**Santhosh Muthalath**

Senior Editor

**Sara Al Gheilani  
Nasebah Al Muharrami**

Translation

**Ahlam Al Wahaibi**

Design & Layout

**Photography Dept., CET**

Photography

**Salim Al Sudairi**

Circulation



SQU-info



@SQU-info



90199997



## Economic Diversification

The growth mode of the Sultanate of Oman has delivered strong economic and social outcomes over several decades since 1970. The economy of the Sultanate still relies on oil as the main source of export and fiscal revenues. Over the years, the government has increased public sector employment and spending on infrastructure, health, and education. This has helped raise standards of living and support private sector activity. According to a report prepared by the Institute for Capacity Development and Middle East and Central Asia Department at the International Monetary Fund, the current growth model of the GCC nations has weaknesses, especially in the backdrop of fall in oil price in the international markets. Hence, increasing economic diversification is paramount; and the countries including the Sultanate have started taking steps forward to achieve this goal. Greater diversification would reduce exposure to volatility and uncertainty in the global oil market, help create private sector jobs, increase productivity and sustainable growth, and establish the non-oil economy that will be needed in the future when oil revenues start to dwindle.

The International Monetary Fund report says that a number of policies have been adopted to diversify the GCC economies and reduce their reliance on oil. A stable, low-inflation economic environment has been achieved, the business climate has been strengthened, education has been expanded, trade and foreign direct investment has been liberalized, and the financial sector deepened. Nevertheless, to date these diversification strategies have yielded mix results. The share of non-hydrocarbons output in GDP has increased steadily but is highly correlated with oil prices, and progress with export diversification, a key ingredient to sustainable growth, has been more limited. International experience shows that diversifying away from oil is very difficult. Success or failure appears to depend on the implementation of appropriate policies ahead of any further decline in oil revenues. Malaysia, Indonesia, and Mexico perhaps offer the best examples of countries that have been able to diversify away from oil. In addition to creating a favourable economic and business environment, these countries focused on export diversification and quality upgrading by encouraging firms to develop export markets and by supporting workers in acquiring the relevant skills and education to boost productivity. In the meanwhile, as H.E. Dr. Tun Mahathir Mohamad, former Prime Minister of Malaysia said, the Sultanate can tap its tremendous tourism potential and vast mineral resources towards achieving economic diversification to attain further development.



Horizon invites contributions from SQU members of staff and faculty. Contributions in the form of articles, news, travelogues, stories of unique and interesting experiences, encounters, etc., are welcome. Contributions may be edited for the sake of clarity and length. Please send your contributions to [horizon@squ.edu.om](mailto:horizon@squ.edu.om) preferably, as MSWord attachments. Authors will be suitably credited.

The views and opinions expressed in the articles published in this newsletter are those of the authors and are not to be construed as the official views of the publication. Horizon is published three times a month by the Department of Public Relations and Information, Sultan Qaboos University, P.O. Box 50, P.C. 123, Muscat, Sultanate of Oman.

Phone: +968 24141045  
E-mail: [horizon@squ.edu.om](mailto:horizon@squ.edu.om)

Fax: +968 24413 391  
Website: [www.squ.edu.om](http://www.squ.edu.om)



## SQU, OSHRM Sign Cooperation Project



Sultan Qaboos University signed a cooperation project with the Omani Society for Human Resources Management (OSHRM) to promote cooperation in different fields related to guiding students on career search, career development and preparing them for the job market. The cooperation project between the two organizations is expected to promote SQU's efforts to harmonize its outputs with the job market in the Sultanate by joining hands with organizations specialized in this area.

The cooperation agreement was signed by Prof. Amer bin Ali Al Rawas, SQU Deputy Vice Chancellor for Academic Affairs & Community Service, and Dr. Ghalib Saif Al Hosni, Chairman of the Omani Society for Human Resources Management. As per the agreement, the OSHRM will extend consultation and technical support services to SQU in career guidance, human resources management and related topics and help the university to organize events on career development and human resources management. The cooperation project also seeks to market SQU's academic programs and specializations in the job sector and promote research and studies related to job market.

The university's facilities and the resources at the Centre for Career Guidance at SQU will be utilized for training purposes support by OSHRM. The university will provide information on its academic programs and data about its graduates to OSHRM. The Society will encourage students from SQU to participate in conferences and other activities organized by it from time to time.

## VC's Visit to Czech Republic, Slovakia Ends



H.E. Dr. Ali bin Saud Al Bimani, the Vice Chancellor of Sultan Qaboos University and his accompanying delegation, concluded an official visit to educational institutions and universities in the Czech Republic and Slovakia. The delegation included H.H. Sayyidah Dr. Muna bint Fahd Al Said, Assistant Vice-Chancellor for International Cooperation, Prof. Khalifa Al-Jabri, Dr. Khalid Al Dhuhli, Dr. Alia Al Ansari and Mahmoud Al Kindi.

The delegation visited several academic and research institutions, the most important of which is Charles University. The two universities signed a letter of cooperation in the field of student exchange and academic training of medical students, as well as the exchange of academic experience and joint research in medicine, science and education. The delegation visited the Charles University Hospital Motel to learn about modern diagnostic methods for certain genetic diseases. It was agreed to host a group of medical students at Charles University to spend the training period at the Faculty of Medicine and Sultan Qaboos University Hospital.

The delegation also visited the Czech University of Technology. The two universities signed a joint letter of cooperation in academic exchanges, training of technicians, student exchanges, joint research and seminars. On the sidelines of the visit, some meetings were held with Slovak Deputy Prime Minister, Minister of Foreign Affairs and Minister of Education, Research and Sport, during which they discussed the development and enhancement of scientific cooperation between SQU and the Slovak scientific institutions in various fields.

## SQU Implements Operational Risk Management Framework

The Sultan Qaboos University (SQU) recognizes the importance of managing risks in an ever-evolving and highly competitive environment of a Higher Educational institution (HEI). The Sultan Qaboos University has established a fully functional risk management office responsible for the end-to-end management of risks posed to the Sultan Qaboos University. In this, the function has embarked upon development and implementation of risk frameworks for effective and efficient management of risks guided by the COSO: Enterprise Risk Management Framework. Operational risks stands as one of the key inherent risks posed to SQU. Moreover, the size and spread of SQU as a prominent HEI in the region makes it imperative to manage the various operational risks faced by it.

The Risk Management office presented the first risk framework for Operational Risk Management to a wide audience under the auspices of Prof. Ali Al Shuali, Deputy Vice Chancellor for Administrative & Financial Affairs. The framework, guided by COSO: Enterprise Risk Management framework is divided into two main pillars i.e. risk self-assessment and operational risk incident / accident reporting.

The framework was presented by Mrs. Qurat al Ain Khan, Expert – Risk Management, Sultan Qaboos University who shed light on the importance of setting up a robust operational loss management system across the University operations by capturing empirical, all current and future

incidents in the University. The collection of such loss data will enable the management to assess and avoid future operational losses by taking appropriate mitigating measures thereby affecting the operational expenses of the University positively. She further stated that the implementation of the risk assessment framework would build a risk culture where each staff of the University will be aware of and eventually self-manage risks at their end. She further concluded by adding that she is hopeful that more and more HEIs in the country and the neighboring region will adopt such risk practices in the HEIs and reap both tangible as well as intangible benefits. The Risk Management Office also presented the Food safety Guidelines timely in wake of the holy month of Ramadan. An initial draft of the guidelines was presented and several do's and don'ts concerning food habits and intake were also released in wake of the holy month. The Food Safety Guidelines have been introduced in SQU for the first time and the guidelines are in line with food safety standards used in Oman as well as compliant with ISO standards. Mrs. Abeer al Kharousi has been with Sultan Qaboos University for over a decade and is a Dietician and Supervisor, Food Safety Unit at SQU.

Dr Salim Al Harthi, Director of Risk Management, Sultan Qaboos University, commented that the risk management in HEIs is of growing importance especially with the competitive and quickly evolving environments in the HEIs worldwide.



## Pesticides Exposure and Cancer Risk

By: Mostafa Waly, PhD  
Department of Food Science and Nutrition  
College of Agricultural & Marine Sciences



Pesticides are widely used throughout the world because of their benefits to maintain high quality and quantity of agricultural products. There is growing epidemiological evidence that exposure of humans to pesticides correlate with an increased incidence of cancer. Agricultural health studies often established a positive correlation between occupational exposure to pesticides and different types of cancer; however, data on non-occupational exposures are scarce to draw any conclusion. The frequency of cancer diagnosis has increased dramatically among adults population, and there are no studies addressing the impact of pesticides or their residues on cancer development among high-risk groups of adults' population. Cancer is the second leading cause of chronic diseases-related death among adults, yet there is no enough information to link pesticides exposure and cancer incidence.

The presence of a detectible pesticide residue in an edible food should be at levels far lower than those that are considered health risks as indicated by USDA's Pesticide Data Program. Western epidemiological and agricultural health studies reported the effect for pesticides-associated carcinogenesis in multiple human organ systems such as breast cancer, prostate cancer, lung cancer, brain cancer, testicular cancer, colorectal cancer, pancreatic cancer, esophageal cancer, stomach cancer, brain cancer, skin cancer, and non-Hodgkin lymphoma. There is mounting evidence on the link of pesticide's exposure with the incidence of cancer at higher rates among pesticides manufacturing workers, applicators, farmers, and farms inhabitants. In many countries, agricultural workers and farmers as compared to the general population have higher rates of cancer incidence, for example, farming communities in the United States have higher rates of leukemia, non-Hodgkin lymphoma, multiple myeloma, and soft tissue sarcoma, as well as cancers of the skin, lip, stomach, colorectal, brain, and prostate. Even though no one set of risk factors explains these higher cancer rates, the range of environmental exposures in the farming community is of concern; where farmers, farm workers, and farm family members are exposed to substances such as pesticides, engine exhausts, solvents, dusts, animal viruses, fertilizers, fuels, and specific microbes that may account for these elevated cancer rates.

Risk factors that are often related to the risk for cancer incidence are generally classified as non-modifiable or modifiable factors. Non-modifiable factors that are often related to cancer incidence rates are age, gender, family history, and genetic predisposition. Modifiable risk factors that are often discussed with increased cancer risk are smoking, low intake of dietary antioxidants, B-vitamins deficiency and Obesity. Cancer may also be linked to modifiable risk factors that are classified as environmental; these environmental risk factors can be altered or changed as they relate to personal behaviors, dietary intake, lifestyle and occupation. Pesticides exposure among general population represents an environmental risk factor in relation to cancer development, and represents a missing component of the present knowledge, as there is a lack of evidence in the current available

literature. Pesticides are unique, intrinsically toxic chemicals designed to be deliberately spread into the environment to kill off pests. They are comprised of many different categories of chemicals and approximately 5.2 billion pounds were used worldwide in 2006 and a similar amount in 2007, but only 1% of this amount reaches the target pests at lethal doses.

Herbicides account for the largest portion of that amount, followed by other pesticides, insecticides and fungicides. Exposure to pesticides can occur through multiple pathways (e.g. food, drinking water, residential, occupational) and routes (oral, inhalation, dermal). Although the contribution of a given route or pathway to overall exposure depends on the pesticide, it is the totality of exposure, by multiple routes and multiple pathways, what determines the risk. Given that humans are much larger than the target species for pesticides, they are expected to be unaffected by small amounts of these compounds. However, pesticides are indeed toxic to humans not only at high doses, responsible for acute poisonings, but even in low doses, as there are mixtures of pesticides that might synergize through the long-term exposures and lead to an array of health effects (respiratory, reproductive and developmental toxicity) and human chronic diseases, including cancer. Pesticides are often applied in mixtures to crops, their residues can be found in foods, drinking water, and aquatic environment, including surface waters that support aquatic life.

Based on rising evidence given by epidemiological and agricultural health studies associated with exposure to pesticides and carcinogenesis, the International Agency for Research on Cancer has considered chronic low-dose exposure to pesticides as one of the important risk factors for cancer incidence. Therefore, carcinogenicity tests are now applied to detect carcinogenic potential of pesticides before allowing them to be marketed. These carcinogenicity testing is conducted by the Environmental Protection Agency, and it is a long-term (around two years) rodent bioassay using two species of both sexes, and according to a new list of chemicals evaluated for carcinogenic potential by EPA's pesticide program published in 2010, more than 70 pesticides have been classified as a probable or possible carcinogen. This classification has been accomplished based on the information extracted from animal genotoxicity and mutagenicity-based studies, and there is a need for human-based clinical trials to address these issues.

Taken together, pesticides-associated carcinogenesis as discussed above is considered as the major disorder affecting public health in the 21st century. The relationship between cancer risk and environmental exposures, particularly pesticides increasingly continues to strengthen. Near to all studies carried out in the area of pesticides, and cancer are categorized in the field of epidemiologic evidence or experimental animal investigation with no mechanistic insight into the cancer development. It should not be forgotten that these mechanisms work alongside or sequentially rather than singly, or they even can potentiate genetically susceptible individuals.



# 21st Century Skills Described as Employable Criteria

Dr. Victoria Tuzlukova & Saud Al Rashdi  
Centre for preparatory Studies

Nowadays, the concept of 21st century skills is no longer a technical jargon of our world, but an abstract idea to publicize employable criteria. There is the need to ensure that higher education in Oman is suitably adapted to equip students with effective skills, which are regarded as key requirements for a successful professional career in the 21st century, and draw attention to the importance of these skills.

In an exclusive interview to Times of Oman back in 2010, H.E. Dr. Abdullah Mohammed Al Sarmi, Undersecretary at the Ministry of Higher Education, said: "As the job market is undergoing rapid changes, so we have to train our students adequately to meet the growing demands". According to Dr. Al Sarmi, "a major aim of higher education sector is to assist the Sultanate in gaining a comparative advantage in the global economy by producing graduates who are fit to meet the growing job market demands, and have technical competence in core disciplines as well as generic skills, such as critical thinking, problem-solving and communication skills".

Acknowledging the given importance of skills that optimize students' employability chances and professional success, as well as the value of the initiatives aimed at connecting the education systems and the needs of 21st-century employers, public and private, and jobseekers, The Research Council (TRC) funded project titled "Skills for 21st century training in higher educational institutions in Oman: Helping students realize their potential in relation to the job market" is now being conducted by a collaborative team of researchers from the Centre for Preparatory Studies and College of Education at Sultan Qaboos University.

The study investigates how critical thinking and problem solving skills are taught in higher education institutions in Oman, and focuses on teaching strategies that are helpful in moving students toward the skills for the 21st century, and assisting them to be more creative and competitive through developing critical thinking and problem solving skills. It also aims to investigate and analyze the requirements of the job market and the types of minds and skills needed for success in the job market as communicated to administrators in higher educational circles.

The current focus of the study is on the perceptions of needs for employability, and the demands of the workplace. The preliminary results obtained through semi-structured in-depth interviews with the representatives of twenty-three leading business companies and local

organizations in Oman reveal that local job market seeks individuals who can think critically and act logically to evaluate situations, as well as understand and solve problems. To this end, there is also an acute need for such individuals who possess adequate oral and written communication skills supported by solid content knowledge. Other critical attributes include skills related to data analysis, decision making and application of specialized knowledge from various fields.

The promising pedagogy for addressing the need for increasing students' learning outcomes regarding these skills and attributes involves, as suggested by Anna Rosefsky Saavedra and V. Darleen Opfer (2012), such lessons as teaching through the disciplines and making it relevant; developing thinking skills and encouraging learning transfer, addressing misunderstandings directly and teaching students how to learn, treating teamwork like an outcome, exploiting technology to support learning, and fostering creativity. Consequently, classroom topics should include practice of making curriculum contextually relevant to students' lives and contemporary complex world (Wagner, 2008), and encourage learning transfer in which students can apply their skills and knowledge to different academic and professional environments. Use of technology can also facilitate the development of students' skill sets while transforming the process of learning into an invigorating experience.

## The Research

The study titled "Skills for the 21st century training in higher education institutions in Oman: Helping students realize their highest potential in relation to the job market" aims to investigate how critical thinking and problem-solving skills necessary for the 21st century are incorporated in the curricula and taught in Oman's Higher Education Institutions. It is premised on the assumption that there is misalignment at the intersection of higher education and workforce, resulting in a mismatch between the demands of the workplace that needs individuals who can think critically and act logically to evaluate situations; understand and solve problems; analyze data and make decisions; access and apply specialized knowledge from various fields. Does the current training of critical thinking and problem solving skills in higher educational institutions in the country match the demands of the competitive workplace? The study will enable educators and decision makers to gain a better understanding of the modern corporate culture and cognitive demands of the workplace, exploring skills training that optimizes student success in Oman.



## Information Systems Students Earn Accolades for Paper



A group of undergraduate information systems students published and presented a paper on Blood Donation Self-Assessment system at the 29th IBIMA conference in Vienna, Austria, in May 2017. The paper will be indexed shortly in SCOPUS and Web of Science databases. The article was published Latifa Ali Issa Balhaf, Noor Nasser Al-Dhuhli and Rawan Salim Ba-Omar, under the supervision of Dr. Kamla Ali Al-Busaidi, an Associate Professor and the head of the information systems department. The paper was presented at the conference by Latifa Ali Issa Balhaf and Rawan Salim Ba-Omar. This publication was based on a group project in knowledge-based systems major elective course taught by Dr. Kamla Al-Busaidi. Throughout the last years of running the course, several students made conference/journal publications to demonstrate the acceptance and the value of expert systems application in several domains such as medicine, agriculture, education, Zakat, entrepreneurship and others. The aim is to encourage young Omani students to start a culture of scientific research. Conference chairs and attendees are very impressed by the quality of the SQU undergraduate students.

Blood donation is an important concern for the society, estimating that most of the deaths in some nations occur due to inadequate supply and availability of safe blood and its component. One of the methods to ensure the safety of both the donor and recipient the blood bank uses "The Donor HEALTH Assessment Questionnaire (DHAQ)", which will determine the eligibility of the donor. The objective of this article is to illustrate the process of developing an expert system that enables blood donation self-assessment. An Expert system (ES) is an Artificial intelligence technology that emulates the decision-making ability of a human expert. Developing the system began with eliciting knowledge from various sources such as: interviews with a domain expert from the Hematology department, journal articles, websites, applications, and paper based donation forms. The ten potential users who evaluated the systems indicated that agreed to strongly agreed that the system inputs are relevant, accurate and understandable. They also agreed to strongly agreed that the system outputs are relevant, accurate, complete, consistent, understandable and trusted. Finally all the users agreed to strongly agreed that the system is user friendly, has a good respond speed, the system is satisfactory and useful, and they trust the system and intend to use it. They also indicated that the system improves their awareness of the blood donation.

The developed prototype system was to demonstrate the application and value of expert system technology to improve awareness of Blood donation and individuals' eligibility. More development rounds are needed to finalize the accuracy, completeness and usability of this developed system.

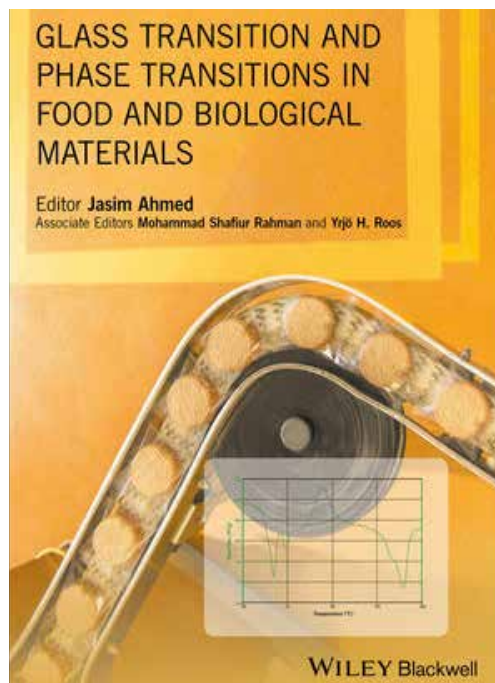
## Successful Breeding of Koi Carp



Under the instruction and supervision of Dr. Wenresti Gallardo, students taking the Fish Reproductive Physiology and Breeding course at the Department of Marine Science and Fisheries of the College of Agricultural & Marine Sciences, were successful in inducing the koi carp to spawn on 16 March 2017. Hundreds of eggs were spawned and two days after, most of the eggs hatched. This is the first report on the successful breeding of the commercially valuable koi carp in SQU and perhaps in Oman. The news has been published in Oman Tribune and Muscat Daily on 1 April 2017. Koi carp is a large ornamental variety of common carp, originally bred in Japan but is now bred in other countries as well. Three years ago, koi carp juveniles were obtained from Thailand through the efforts of Dr. Gilha Yoon, Mr. Ahmed Al-Souti and Mr. Adil Al-Sulaimani. The koi carps are being taken care of in the aquaculture facility at the Agricultural Experiment Station (AES) of the university.

The hundreds of baby fish are divided into two groups: one group is reared at AES and another group at the Department of Marine Science and Fisheries. The baby fish at the Department are being taken care of by the fish breeding students, namely Mohamed Al Wahaibi, Dhabya Al Rasbi, Madrak Al Aufi, Salim Al Mamari, Aisha Al Rahbi, Bushra Al Kharusi, and Mohammed Al Qarni, with the help of Mr. Ahmed Al-Souti who serves as the Technician and Teaching Assistant for the course. The other group of baby fish at AES are taken care of by Mr. Muntaser (MSF staff) with Dr. Gallardo's supervision. It is hoped that the baby fish will grow to adult size and breeding success will continue so that we do not have to import the fish from another country. Adult koi carp with beautiful color design can be sold to fish hobbyists at around 50 rials per piece.

Through the fish-breeding course, the students learned not just the theory but the practical aspects of inducing fish to spawn and rearing the baby fish as well. As a contribution of Sultan Qaboos University to the aquaculture development in the Sultanate of Oman, the Department of Marine Science and Fisheries at the College of Agricultural and Marine Sciences has enhanced its curriculum by offering new aquaculture courses namely Fish Reproductive Physiology and Breeding, Fish Nutrition and Feeding, Fish Pathology, Aquaculture Systems and Engineering, Aquatic Animal Health Management, and Aquaculture Development and Management of its Environmental Impacts, in addition to the existing courses on basic aquaculture and tropical marine aquaculture. Through these courses, students learn the theory and practice of aquaculture and prepare them to contribute to the aquaculture development of the country.



## Book Reflects on Glass Transition in Foods

Recently, Wiley Blackwell, West Sussex, UK published “Glass Transition and Phase Transitions in Food and Biological Materials” co-edited by Prof. Shafiur Rahman from the Department of Food Science and Nutrition, College of Agricultural and Marine Sciences, Sultan Qaboos University, Dr. Jasim Ahmed from the Kuwait Institute for Scientific Research, Kuwait, and Prof. Yrjo H. Roos from the University College Cork, Ireland. This is tenth book of Prof. Rahman who has extensive research in structural characterization of foods and biomaterials. In the last few decades, it is clearly identified that glassy state significantly affected the stability of foods and biomaterials. In the glassy state, molecules are kinetically immobilized and chemical reactions become very slow in the order of years. Glass has three important characteristics, transparent, brittle and relatively inert. These three characteristics are important for many foods, for example hard sugar candy should be transparent, potato chips should be brittle, and stable foods possess inert characteristic.

This new book is intended to provide profound and the most up-to-date information on the glass transition of various foods and biopolymers, their measurement techniques, influence on the thermomechanical properties, and above all, discussions on the most sought-after biopolymers in today's market, including polylactides, gelatine, and chitosan. It is explained in the book how the glass transition concept has been employed to food micro-structure, food processing, product development, storage studies, and packaging development, and so on.

The book contains 17 chapters. The chapters have been covered from basics of phase transitions (thermodynamics, the phase diagrams, phase equilibrium and stability) to real applications to food (dehydrated, sugar-rich, starch and proteins), and biopolymer (polylactides, gelatin and chitosan). The first chapter is an introductory one, the concept and applications of the glass transition and phase transitions are discussed. Water influences the thermal and relaxation properties of various biopolymers. Two chapters elaborate plasticizing effect of water in various food matrixes (sugar in solutions and food, and folded proteins) (Chapter 2) and relationship between glass transition, water plasticisation and relaxation times (Chapter 6). Thermodynamic and kinetic parameters pertaining to the glass transitions of foods and their stability are presented in Chapter 3.

Recently, high-pressure processing (HPP) – a novel processing technology has been adopted by food processing industry for retaining quality of food. Two chapters on HPP are included in the book. Chapter 4 describes the effect of HPP on the glass transition properties of globular proteins with potential industrial applications. Another chapter (Chapter 17) focuses on the basic principles and applications in aqueous and food systems that are involved in high pressure freezing and thawing purposes. Chapter 5 covers the phase diagrams, phase equilibrium and stability, melting and crystal-

lization behaviour of major food items and biopolymers are discussed. The kinetics of crystallization processes, and applications to food systems have been presented in Chapter 8.

Biopolymers have limitation for practical applications because of their brittleness, poor thermal and optical properties, poor moisture and gas barrier. In order to overcome these problems, plasticizers are incorporated to provide the necessary workability and adequate flexibility to biopolymers. The chapter 7 focuses on recent advances in the selection and use of plasticizers for the most widely studied biomaterials including starch, protein and poly(lactic acid) and their impact on the performance of these materials. Recently, biodegradability and biocompatibility are the major issues for selection of polymeric materials intended either for packaging or biomedical applications. Among available biopolymers, lactic acid based polymers known as polylactides (PLA) and chitosan are the most promising for industrial applications. These materials are compostable, thermoplastic, and exhibited excellent thermomechanical properties when blended with other biopolymers or nanoparticles. Thermal properties of some selected biopolymers are discussed in Chapters 13 and 14. Characterization of the protein molecules through thermal analysis has been described in Chapter 15.

Thermal, mechanical, and microstructural properties of hydrated gluten networks have been discussed from a materials' science perspective in Chapter 9. Food materials undergo the phase and state transitions associated with heat and mass transfer during dehydration. The kinetics of water removal and structural relaxation rates can be analyzed and modeled to manipulate structural properties of dehydrated solids and also the quality of the dehydrated materials. The implication of glass transition to drying and stability of dried foods and water-glass transition temperature profile during spray drying of sugar rich foods are discussed in Chapter 10 and 11, respectively. The state diagram is a stability map of different states and phases of a food as a function of solids/water content and temperature. Chapter 12 discusses the development of the state diagram of foods followed by its applications in determining food stability during storage and processing. The amylopectin crystallites break down during heating of starch in presence of sufficient amount of water, and the starch molecules gelatinize. Pasting properties of starch and influence of particle size, hydrocolloids and high-pressure are presented in Chapter 16.

Editors believe the book will be useful to food professional working in the area of food processing, packaging, pharmaceuticals, biotechnology, polymers, and other industrial and academic professionals with interests in phase and glass transitions. This book can serve the missing link between food/biological science and material science/polymer engineering, and could help to understand the concept of thermal properties and applications lucidly.



# What's Next?